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Topics for discussion
On February 14, 2006

Patent Application No.: 10/084,057
Patent Title: METHOD AND SYSTEM FOR MITIGATING NONLINEAR TRANSMISSION IMPAIRMENTS IN FIBER-OPTIC COMMUNICATIONS SYSTEMS
Pub. No.: US 2003/0058504 A1

The examiner wrote that: "The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention." We wish to address this comment as follows. Our application teaches the idea of using the optical pulse shape together with the PSK modulation format to mitigate fiber nonlinearities for high-capacity WDM long-haul transmission system. The optical pulse shape can be quantified by parameters such as the extinction ratio. For a given set of transmission system parameters such as channel spacing, transmission distance, and fiber dispersion parameters, there is an optimal optical pulse shape of the PSK signal that gives minimum bit-error-rate (maximum Q-factor) at the receiver therefore maximizing the transmission performance. Such an optimal optical pulse shape can be produced at the transmitter using a Mach-Zehnder modulator via bias and driving voltage. The optimal pulse shape parameter applicable to the Mach-Zehnder modulator can be obtained once the system parameters such as channel spacing, transmission distance, and fiber dispersion parameters are known. The embodiment of these ideas and matters has been described in detail in our application with examples that can be found in [0214] to [0223] and Figs. 25 to 30.

The examiner wrote that: "Applicant did not disclose the criticality of the pulse shape..." Specific example is described in our application as can be seen Figs. 28 to 30 which disclose the importance of the pulse shape by illustrating how the pulse shape (modulation depth) affect the transmission performance (Q-factor) at the receiver (see Fig. 30).

Regarding Liu's application, it may be possible that the polarization state of Liu's optical pulse can be arbitrary. However, Liu's application requires that the polarization states of two adjacent optical pulses must be orthogonal as depicted in Fig. 2A and 2B. Our application, on the other hand, does not demand such polarization orthogonality of neighboring optical pulses. Each optical pulse of the PSK signal can have arbitrary polarization states.

Regarding claim 88, Walklin discloses two Mach-Zehnder modulators. However, these modulators do not produce QPSK signal. They are connected serially and one of the modulator is driven by a tone generator not a data generator (Fig. 1C). In contrast, our application specified that the two Mach-Zehnder modulators that produce the QPSK signal are connected in parallel with a 90 degree phase shift with both modulators driven by separate data sources (see Fig. 8).

Regarding claims 74 and 86 on NRZ pulse, although RZ and NRZ formats are well-known concept the definition of NRZ pulse in this application is different than the conventional well-known definition of NRZ pulse used commonly in, e.g., Bergano's application. In our application, the term NRZ pulse refers to a pulse having a bell-shaped or sinusoidal-like shape such that the pulse peak does not extend to the entire bit period (see Figs. 28 and 29). Furthermore, the wings of the pulse does not extinguish completely regardless of the bit pattern. This is in contrast to the conventional NRZ signal in which the pulse peak essentially occupies the entire bit period and the edges of the NRZ pulses exist and extinguish almost completely when there is a logical transition from one to zero level. For example, Bergano's definition of NRZ signal is stated as: waveform's value is constant when consecutive binary ones are sent (paragraph [0005] of Bergano). For PSK, NRZ pulse is defined in Bergano's application as signal with waveform's value constant when optical phase of adjacent bits are the same [0046]. The NRZ pulse in this application is clearly defined in the specification with its extinction ratio of at least about 3 dB and less than 8 dB stated, see Figure 1f and paragraph [0068]. Therefore, the term NRZ pulse used here is substantially different than conventional NRZ signal as described by Bergano.

Regarding claims 83 and 91-94, the present invention describes the concept and technique on how to optimize transmission performance of WDM optical channels with PSK format in optical fibers. Taga's RZ pulse addresses the polarization effect only and the extinction ratio is based on single-channel (see Figures 1 and 4 of Taga's patent) OOK format only in which the RZ pulse is simply turned on and off to represent logic values of one and zero (see Figure 2C of Taga's patent). Taga's RZ pulse shape addresses neither fiber nonlinearities nor WDM crosstalk. Furthermore, Taga's optical pulse does not contain phase modulation. The data information is represented by the presence or absence of the pulses. Thus, Taga's specification of the extinction ratio of RZ pulse is not applicable here.